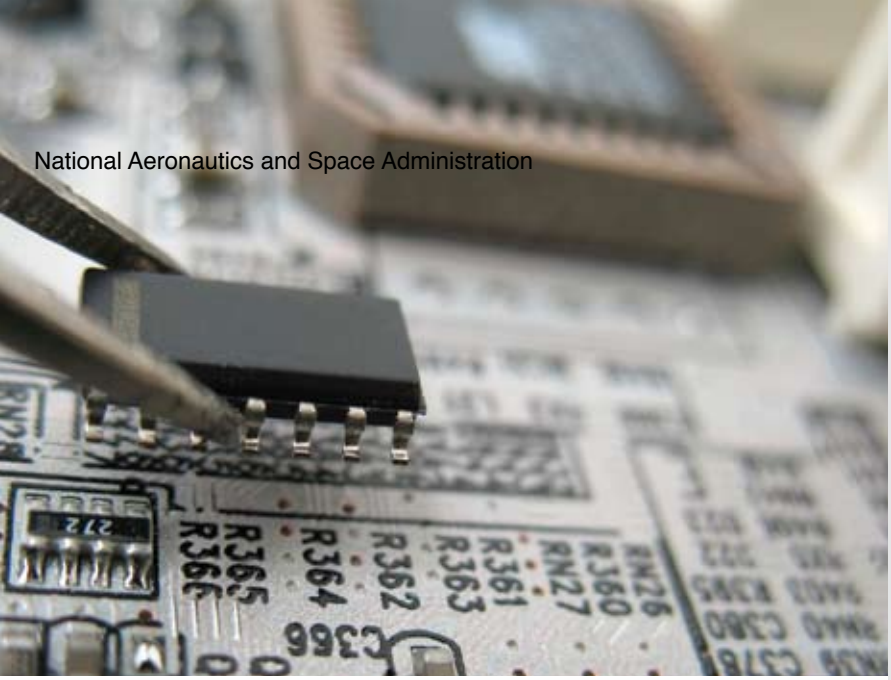

NASA Langley's
X-Ray Diffraction Method
for defect characterization of epitaxially grown cubic semiconductor layers

NASA Langley researchers have developed a novel semiconductor epitaxial growth and characterization technology for rhombohedrally aligned cubic semiconductors on trigonal crystal substrates. Several important semiconductor materials are potentially affected by this technology, including cubic semiconductor alloys of Group IV materials such as silicon (Si), germanium (Ge), carbon (C) and its alloy SiGe, Group III-V materials such as gallium arsenide (GaAs) and gallium phosphate (GaP), and Group II-VI materials such as zinc selenide (ZnSe) and cadmium telluride (CdTe) on various new trigonal substrates. Many of these semiconductor materials are being used or developed for a number of high power, high frequency, optical fiber communication, far-infrared imaging, and high temperature device applications, including cellular communications as one example. This characterization method enables mapping of defect density and defect location, allowing optimization of growth process parameters for fabricating high-quality, defect-free semiconductor devices.

Benefits

- Enables new rhombohedral epitaxy growth of cubic semiconductor alloys on trigonal crystal substrates into defect-free device structures
- Allows defect characterization and wafer mapping for a range of semiconductor materials, including several important compound semiconductor compositions of Groups IV, III-V, and II-VI materials
- Useful for optimization of epitaxial growth process parameters
- Based on newly invented X-Ray Diffraction methods
- Expanded development and application of this innovation for broader use in hetero-crystal-structure epitaxial growth of semiconductors is ongoing
- Patents applied for
- Developed to support NASA's epitaxial growth technology covered in LAR-17185, entitled "Epitaxial Growth of Group IV Cubic Compound Semiconductor Alloys," and other related cases

partnership opportunity

Applications

Commercial opportunities for the semiconductor compositions that can be characterized by this technique are significant. Applications include a number of high-performance, high-speed compound semiconductor devices, including field effect transistors (FETs), high electron mobility transistors (HEMTs), hetero bi-polar transistors (HBTs) used in many demanding end-use applications today. Compound semiconductors have enjoyed rapid market growth over the past several years due to the use of these high-performance devices in applications such as cell phones. Other applications include thermoelectric devices, photovoltaic solar cells, and photon detectors.

The Technology

This innovation is based on two new X-Ray Diffraction measurement methods for integral detection and spatial wafer mapping of twin defects in rhombohedrally aligned cubic semiconductor epitaxial layers. By using this innovation as a quality monitoring and control technique, epitaxial growth methods can be optimized to reduce twin defects commonly observed in the new rhombohedrally grown cubic semiconductors on trigonal crystal substrates.

This technology is described in LAR-17044, LAR-17298, LAR-17299, and others. The technology was developed to support related NASA inventions for epitaxial growth of rhombohedrally aligned cubic semiconductors, as described in LAR-16868, LAR-16872, and LAR-17185 (covered under two patent applications in process, including US20070222034 and US Patent #7341883). Other patent applications are anticipated. The technology was also reported in "Rhombohedral Epitaxy of Cubic SiGe on Trigonal c-Plane of Sapphire," *Journal of Crystal Growth* 310 (2008) 2724–2731.

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

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